UM1874
User Manual

TwisterSIM

Introduction

TwisterSIM is a unique **Electro-Thermal simulator** that helps shorten the design solution cycle by enabling, in a few clicks, complex engineering evaluations with accurate simulations like load-compatibility, wiring harness optimization, fault condition impact analysis, **diagnostic behavior analysis and Dynamic Thermal performance**.

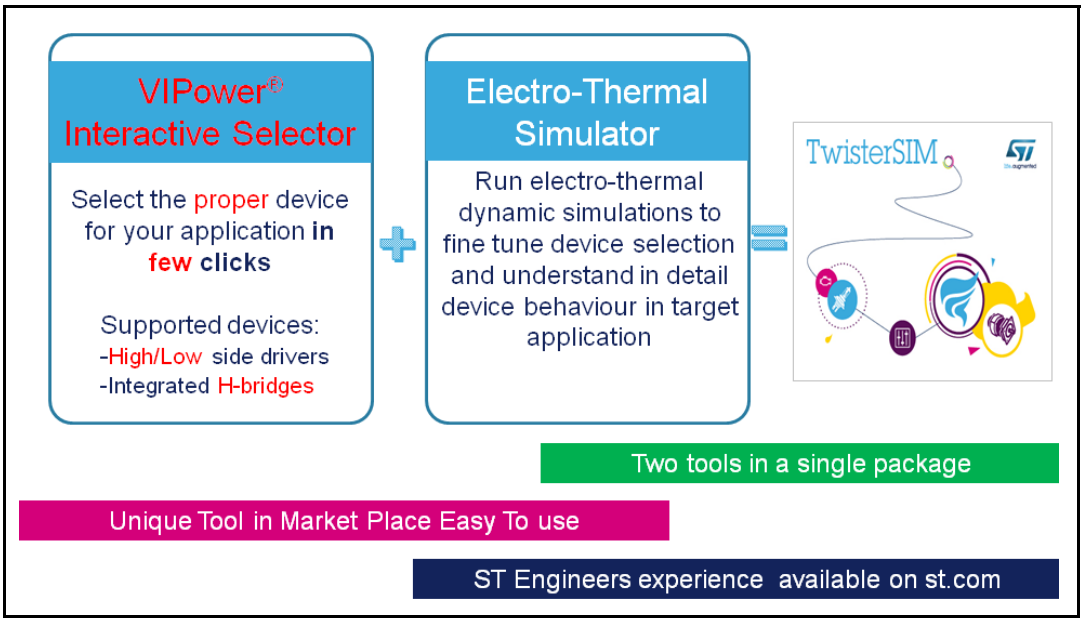
A built-in Interactive Selector provides a short list of suitable devices based on first level system requirements. It assists in detailing the specific system configuration with layout, load and driving profile customization to build an accurate model of the final application.

Simulation results, including junction and case thermal profiles, load current and diagnostic behavior are shown on dedicated scopes views or exported in a number of different commonly used formats.

TwisterSIM supports a large selection of **Low/High-side driver/switches and H-bridges for Motor Control**.

A trial version, to explore the main functionalities of TwisterSIM, is available for download at *www.st.com/twistersim* and it also contains, in the main toolbar, the instructions to request an activation code (free of charge but subject to STMicroelectronics approval) for the full version.

An on-line forum provides additional support to TwisterSIM users. Access to the forum is available at *www.st.com/twistersim-forum*.


VIPower®
Interactive Selector
Select the proper device for your application in few clicks
Supported devices:
-High/Low side drivers
-Integrated H-bridges
Electro-Thermal Simulator
Run electro-thermal dynamic simulations to fine tune device selection and understand in detail device behaviour in target application
TwisterSIM
Two tools in a single package
Unique Tool in Market Place Easy To use
ST Engineers experience available on st.com

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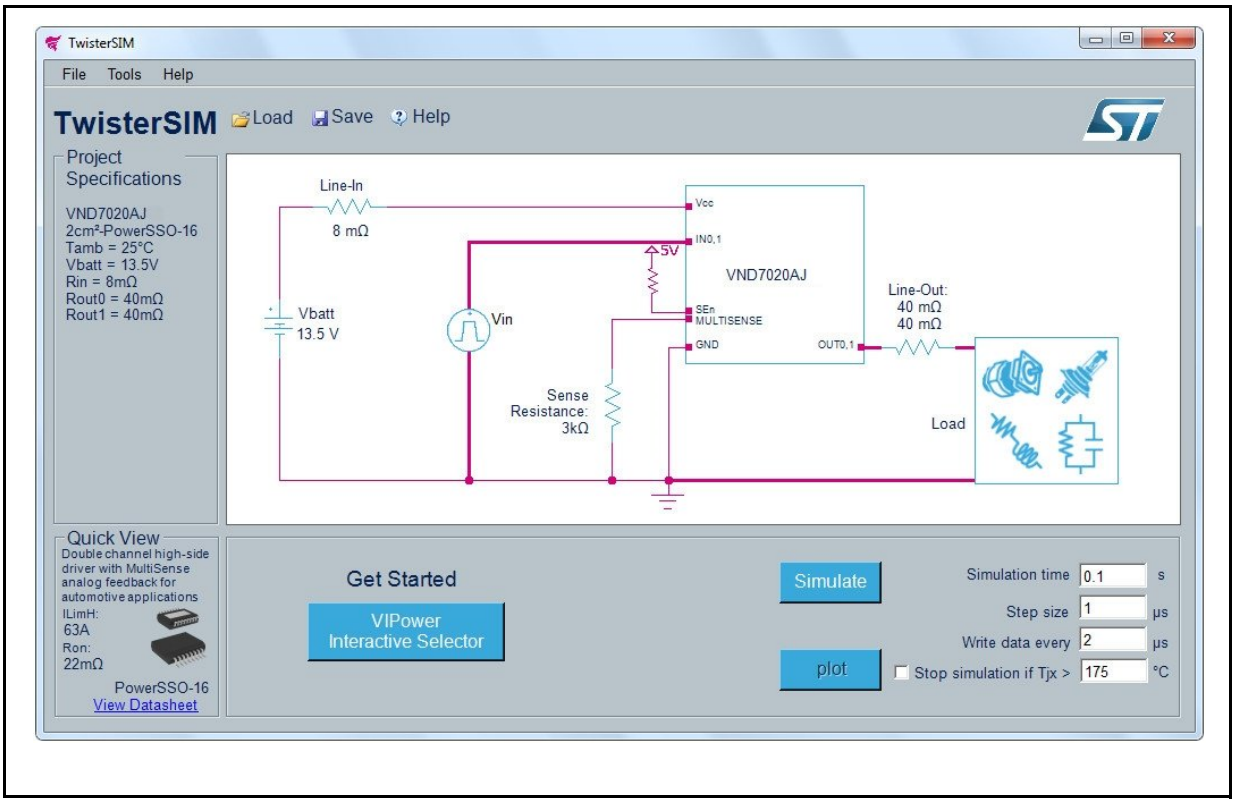
1 Overview

Main start window (*Figure 1*) functionalities:

1. System Layout: it shows a typical control schematic, including a specific device (selectable from a list), supply voltage, line harnesses, common loads and a configurable control input to fit the simulation conditions to a specific architecture
2. Project Specifications: on the left side, the main project information is summarized
3. Simulation pane: on bottom-right part, it allows to customize simulation parameters and open a plot window
4. VIPower Interactive Selector: built-in "Get Started" utility to facilitate device identification based on first level system requirements
5. Quick View: on the bottom side the main electrical data and package info of the device are outlined. The link View Datasheet allows downloading the datasheet.

Figure 1. TwisterSIM main view



On menu items or toolbar:

- Click "File" and select "Load System Layout & Data" or click button, to load a complete system layout and simulation data, previously saved
- Click "File" and select "Save System Layout & Data" or click button, to save a complete system layout and simulation data
- Click "Tools" and select "VIPower Interactive Selector" or click "Get Started" button, to start VIPower Interactive Selector tool
- Click “Help” to view this guide, to read the disclaimer or go to the forum page.

On system layout:

- Click on the components icons to configure and change their values.

On simulation pane:

- Configure simulation parameters (*Section 2.5.7: Thermal electrical simulation setup*) then click "Simulate" button to start simulation.

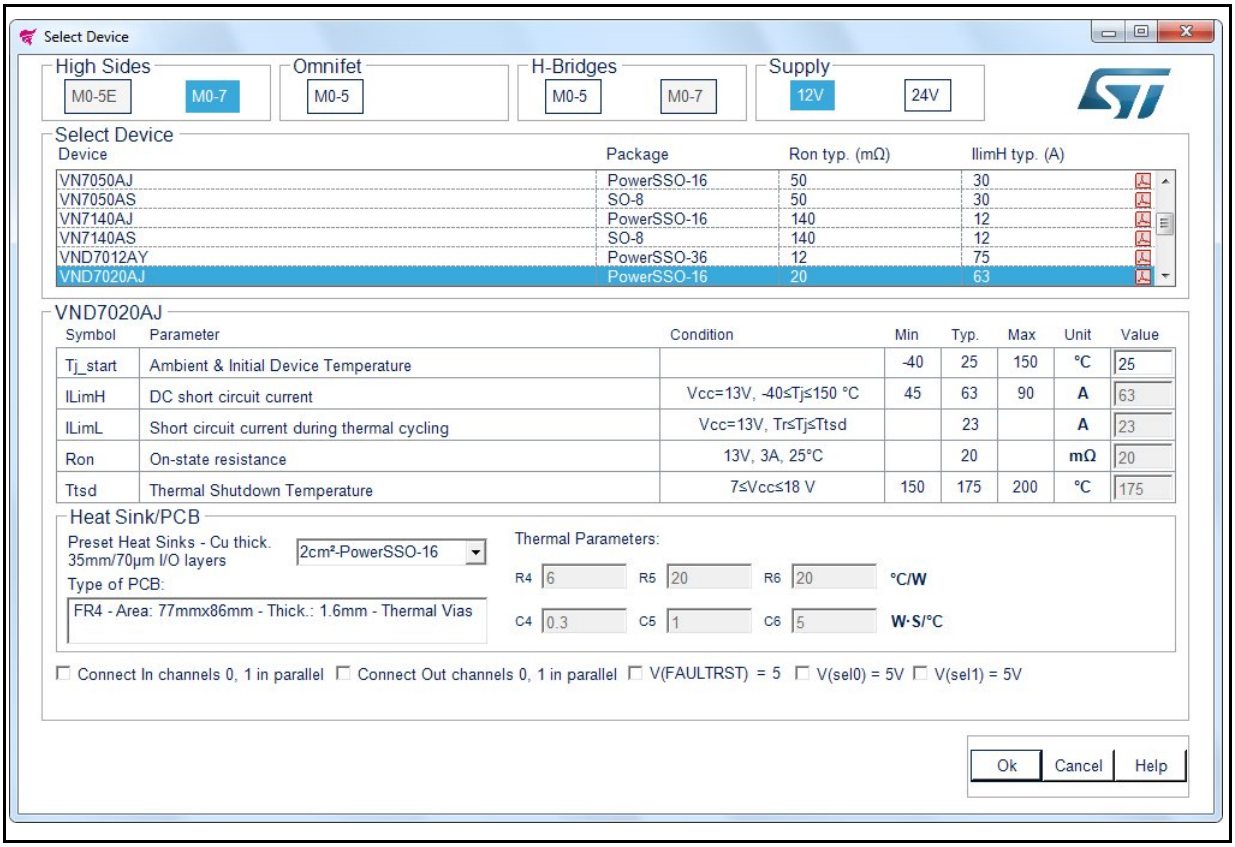
A progress bar indicates the state of the simulation. A plotting window automatically opens when the simulation ends.

2 Electro thermal simulator

2.1 Device selection and parameters setting

Click on the Device Icon in the main window, a new frame opens (*Figure 2*) where a specific device can be selected and the related parameters set.

Figure 2. Device selection and parameters setting



2.1.1 General device parameters

Typical values are preselected for each device. All parameters with a white background may be changed.
Change them manually by inserting a specific value or clicking up/down in the numeric boxes.

The range of values allowed depends on the specific device selected:

- Ambient and Junction temperature at the beginning of the simulation. Accepted values are between -40°C and 150°C for all devices
- ILimH @25°C (A): Output Current Limitation (for Tj < Ttsd)
- ILimL @25°C (A): Output Current Limitation during thermal cycling (for Tj > Ttsd)
- RdsOn @25°C (mΩ): Output drain-source on state resistance
- Thermal Shutdown Temperature (Ttsd,°C). Accepted values are between 150°C and 200°C for all devices
- Turn-off output voltage clamp (Vdemag)
- Cx (°C/W) and Rx (W · S/°C): Thermal Fitting model parameters (see component datasheet for further information).

In PCB pop-up Menu choose from a list of preset Heat Sink (with preset values of Cx and Rx, accordingly to the relevant datasheet) or set "Custom PCB" to manually insert Cx and Rx values.
Values outside the boundaries are automatically restored to the max/min allowed value.

2.1.2 H-Bridge Device parameters

- ILimH (A): High-Side Current Limitation
- ISD_LS (A): Low-Side Shutdown Current
- Ron HS/LS @25°C (Ω): high/low side drain-source on state resistances.

H-Bridge Device selection is not available if Power Profile is selected.
H-Bridge Device selection disables Power Profile, Lamp Selection and Reverse Diode selection in parallel with RL load.

2.1.3 24V Device parameters

- V(FR_Stby) = 5: Check to connect Fault reset standby pin @ 5V.

2.1.4 M07 Device parameters

- V(FAULTRST) = 5: Check to connect Fault reset pin @ 5V
- V(sel0) = 5: Check to connect sel0 pin @ 5V
- V(sel1) = 5: Check to connect sel1 pin @ 5V.

2.1.5 Multichannel Options (2 or 4 channels devices)

- Check "connect In channels in parallel" to connect the Inputs of the channels in parallel. Relevant changes are reflected in the "source section"
- Check "connect Out channels in parallel" to connect the Outputs of the channels in parallel. Relevant changes are reflected in the "load section"
- Click **OK** to accept changes
- Click **Cancel** to restore previous device and parameters
- Click **Help** to read the help file on this topic.

Selected Device name and PCB thermal parameters are reported in the main window. Refer to the relevant datasheet for Device specific parameter ranges.

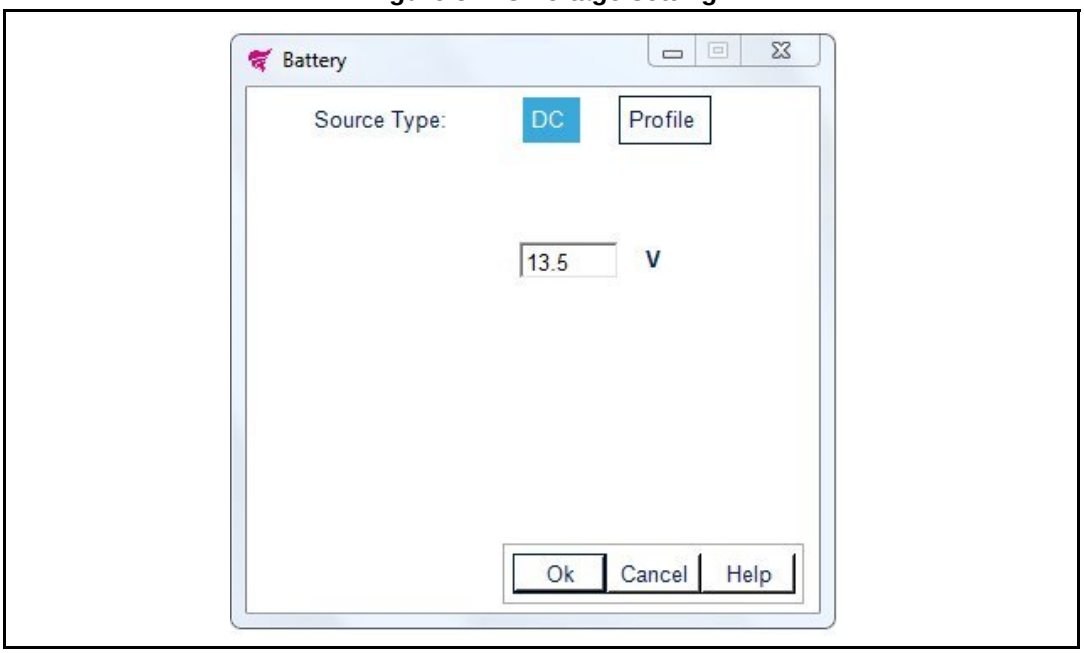
2.2 Source selection and setting

Click on the Battery symbol (Vbatt) in the main window, a new frame opens (*Figure 3*) where the battery voltage can be modified.

Select "DC" or "Profile" to set the Source voltage.

2.2.1 DC voltage setting

Figure 3. DC voltage setting



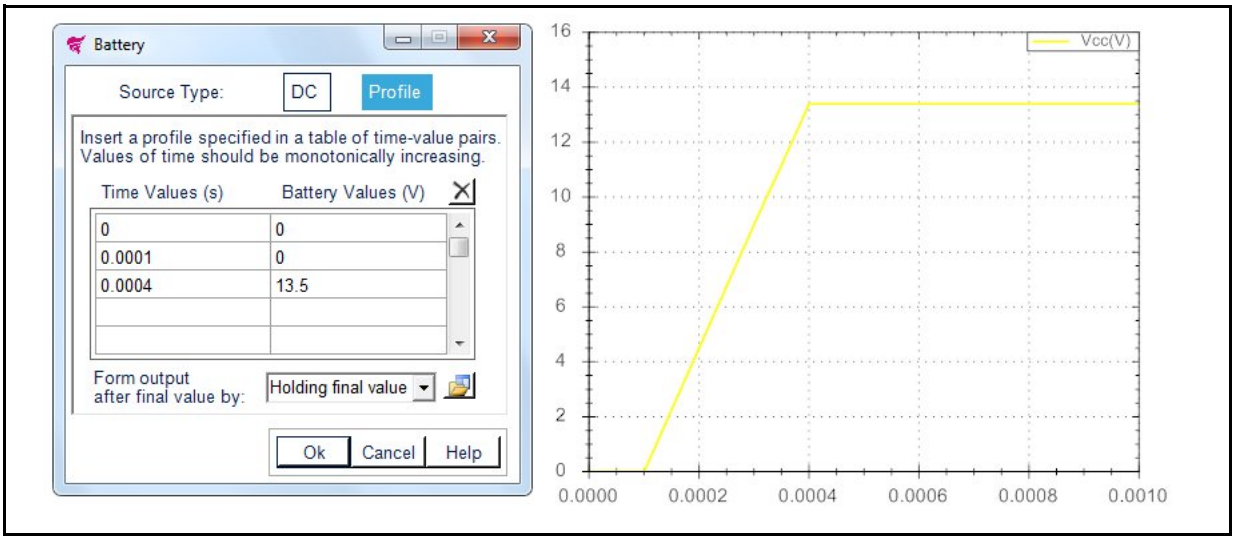
Change the value manually by inserting it in the numeric box.

Values outside the boundaries are automatically restored to the max/min allowed value.

2.2.2 Voltage profile setting

Click Profile, a new frame opens (*Figure 4*) allowing to insert a custom profile by specifying time-values pairs in the corresponding fields or load values from a .txt/.csv file (time values in the 1st column and Voltage values in the 2nd, max 150 rows).

Figure 4. Voltage profile setting



Define the output after the final value by:

- Cyclic repetition (Voltage values sequence is repeated continuously during the simulation)
- Holding final value (Last voltage value is maintained throughout the simulation).

Time values must be inserted as a increasing monotonic sequence (i.e., Tn+1>Tn).

- Click to clear table
- Click to load values from file

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

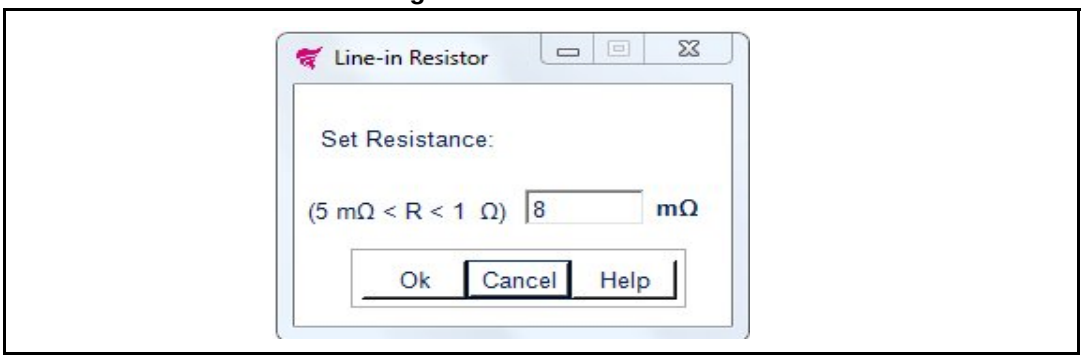
2.3 Line and sense resistances

Click on the Resistors symbols in the main window to change Line-in, Line-out and Sense resistances for analog devices only.

2.3.1 Line-in resistor

Change the value manually by inserting it in the numeric box (*Figure 5*).

Figure 5. Line-in resistor



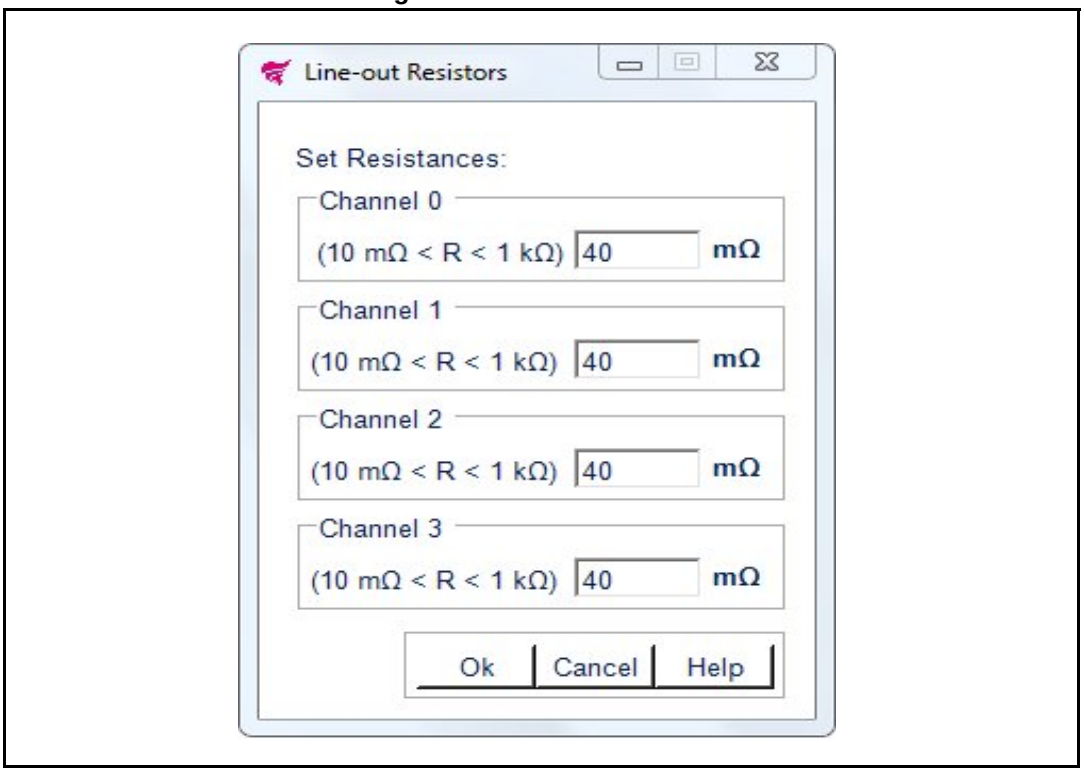
Values outside the boundaries are automatically restored to the maximum allowed value.

Accepted values are between 5mΩ and 1Ω.

2.3.2 Line-out resistors

Change the values manually by inserting them in the numeric boxes (*Figure 6*).

Figure 6. Line-out resistors



Values outside the boundaries are automatically restored to the max/min allowed value.

Accepted values are between 10mΩ and 1kΩ.

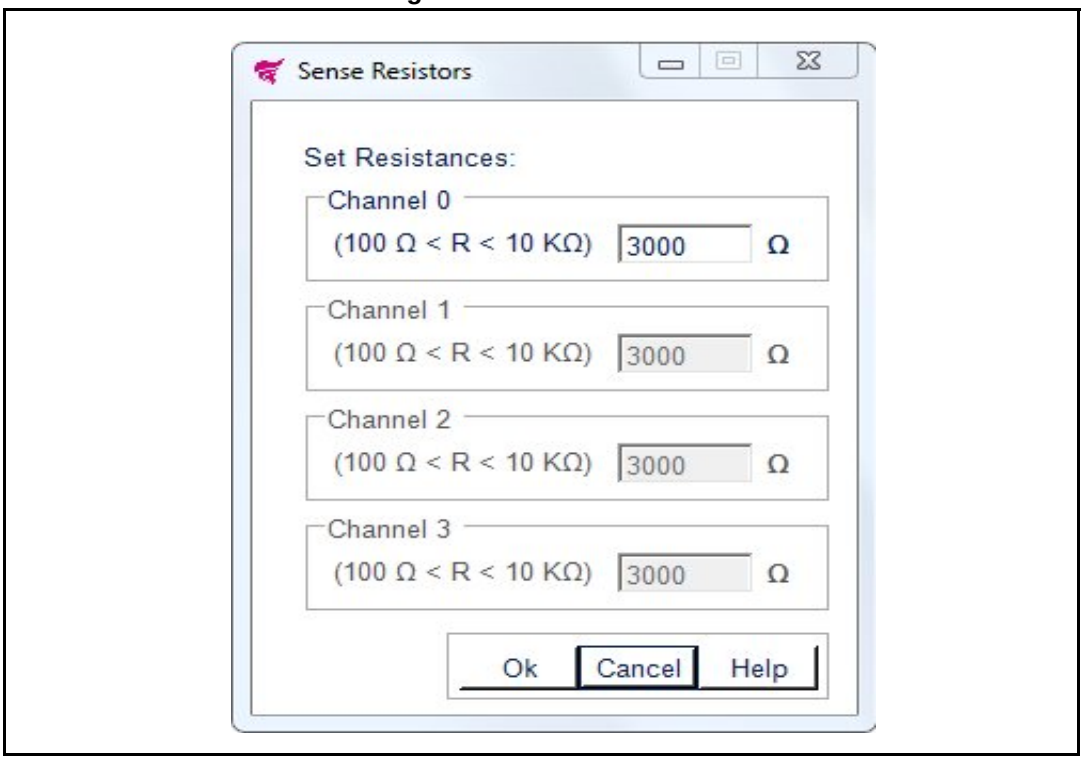
The number of enabled Line-in resistors is equal to the number of output channels for the selected device.

2.3.3 Sense resistors

Only for analog current sense devices, Sense resistors values can be set to simulate current sense diagnostic voltage conversion (*Figure 7*).

Change the values manually by inserting them in the numeric boxes.

Figure 7. Sense resistors



Values outside the boundaries are automatically restored to the max/min allowed value. Accepted values are between 100Ω and 10kΩ.
The number of enabled sense resistors is equal to the number of output channels for the selected device.

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

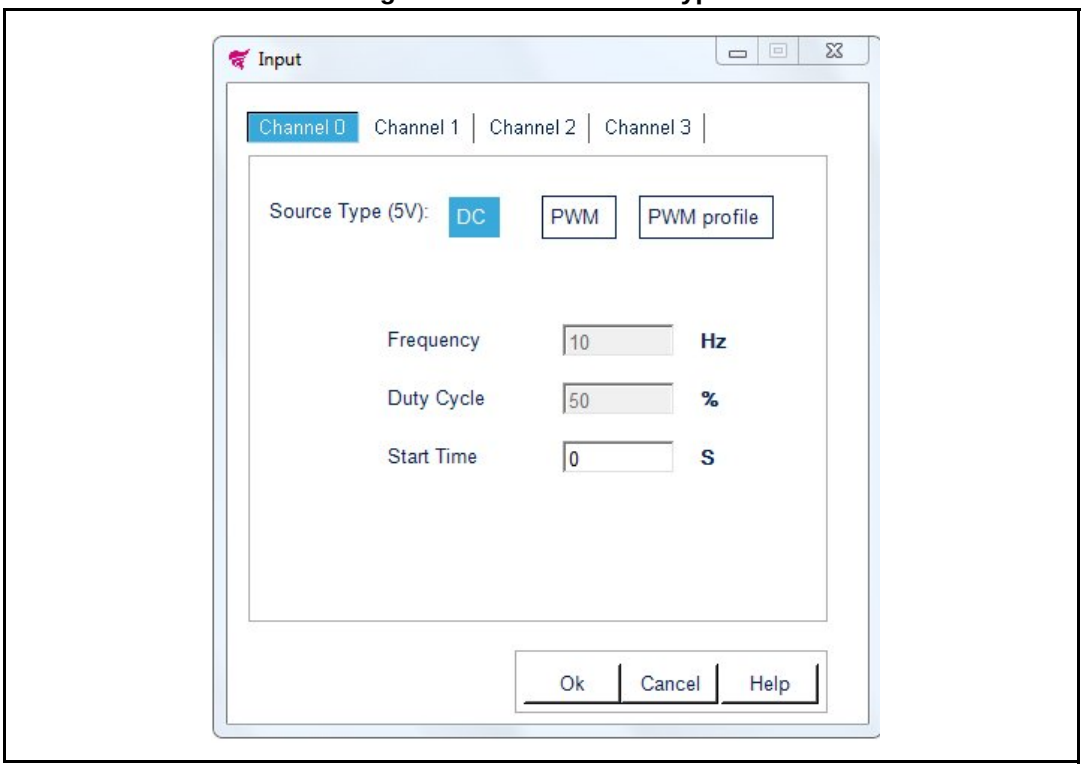
Resistance values are reported in the main window.

2.4 Control source

Click on the Control Voltage symbol (Vin) in the main window, a new frame opens where the control type for each channel can be selected (*Figure 8*).
The number of visible Tabs is equal to the number of output channels of the selected device.

2.4.1 Control source type

Figure 8. Control source type

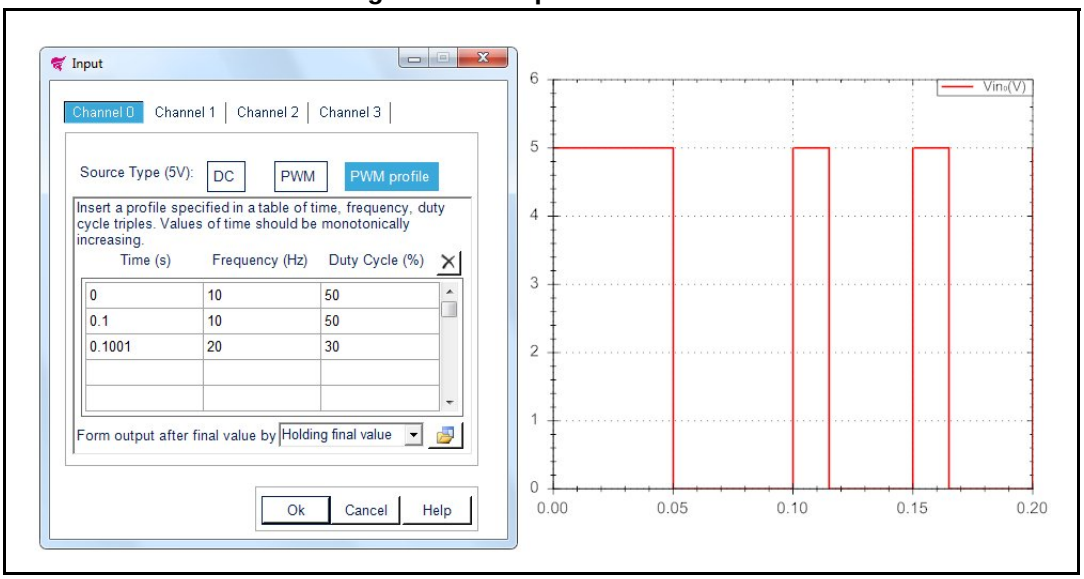


- Selecting "DC" Source type a 5V DC source voltage is applied to the "In" pin, starting from "Start Time".
- Selecting "PWM" Source type a 5V square wave source voltage is applied to the "In" pin, with a specific "Frequency" and "Duty Cycle", starting from "Start Time".
- Selecting “PWM” profile Source type a new frame opens (*Figure 9*) in order to insert a custom profile by specifying time, frequency and duty cycle in the corresponding fields or load values from a .txt/.csv file (time values in the 1st column, frequency in the 2nd and duty cycle values in the 3rd, max 150 rows).

Change the values manually by inserting them in the numeric boxes.

Values outside the boundaries are automatically restored to the max/min allowed value.

Figure 9. PWM profile selection



Define the output after the final value by:

- Cyclic repetition (Frequency and duty cycle values sequence is repeated continuously during the simulation)
- Holding final value (Last frequency and duty cycle values are maintained throughout the simulation)

Time values must be inserted as a increasing monotonic sequence (i.e., Tn+1>Tn).

Click ✕ to clear table

Click 📂 to load values from file

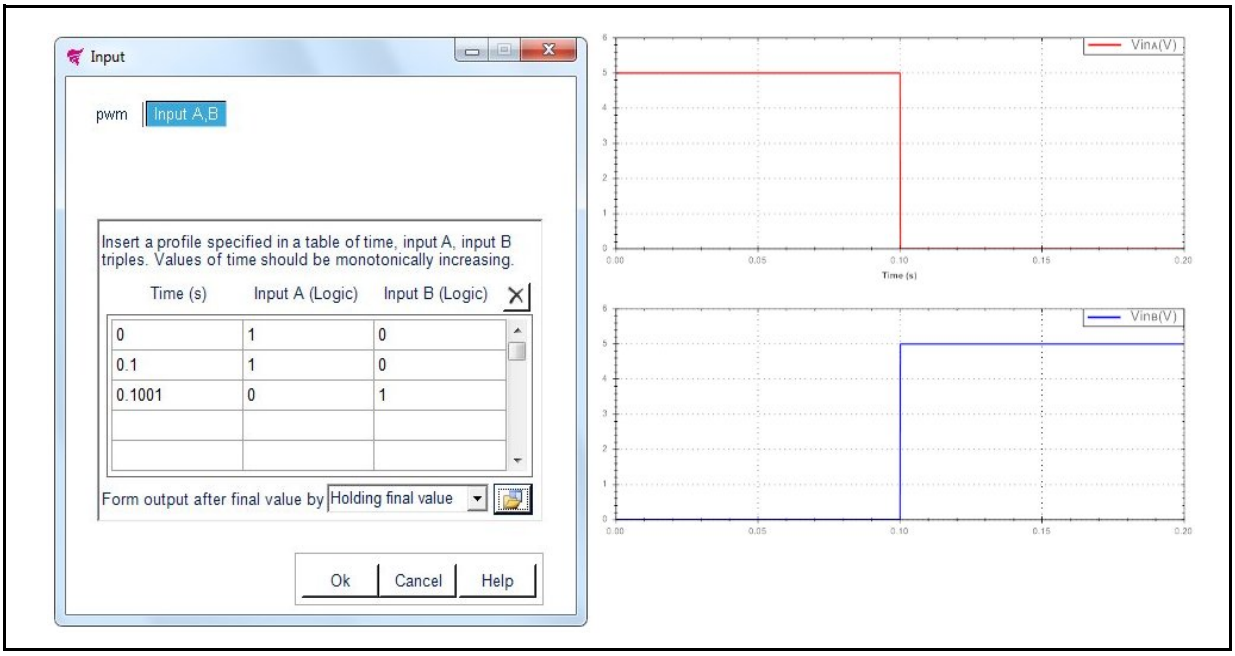
PWM and PWM Profile for the selected channel are not available if Current or Power Profile is selected.
PWM and PWM Profile disable the Current and Power Profile selection for the selected channel.

2.4.2 H-Bridge input setting

Click on the "PWM, Vin A,B" in the main window then select “Input A,B” and a new frame (*Figure 10*) allows inserting a custom profile by specifying time, Input A and Input B in the corresponding fields or load values from a .txt/.csv file (time values in the 1st column, Input A in the 2nd and Input B values in the 3rd, max 150 rows).
Define the output after the final value by selecting:

- Cyclic repetition (Input A and Input B values sequence is repeated during the simulation)
- Holding final value (Last Input A and Input B values are maintained throughout the simulation)

Figure 10. H-Bridge input setting



Time values must be inserted as a increasing monotonic sequence (i.e., Tn+1>Tn). Input A and Input B are logical values:

- Set Input A = 1 and Input B = 0 to activate HS_1-LS_2 diagonal
- Set Input A = 0 and Input B = 1 to activate HS_2-LS_1 diagonal

Click ✕ to reset table

Click to load values from file

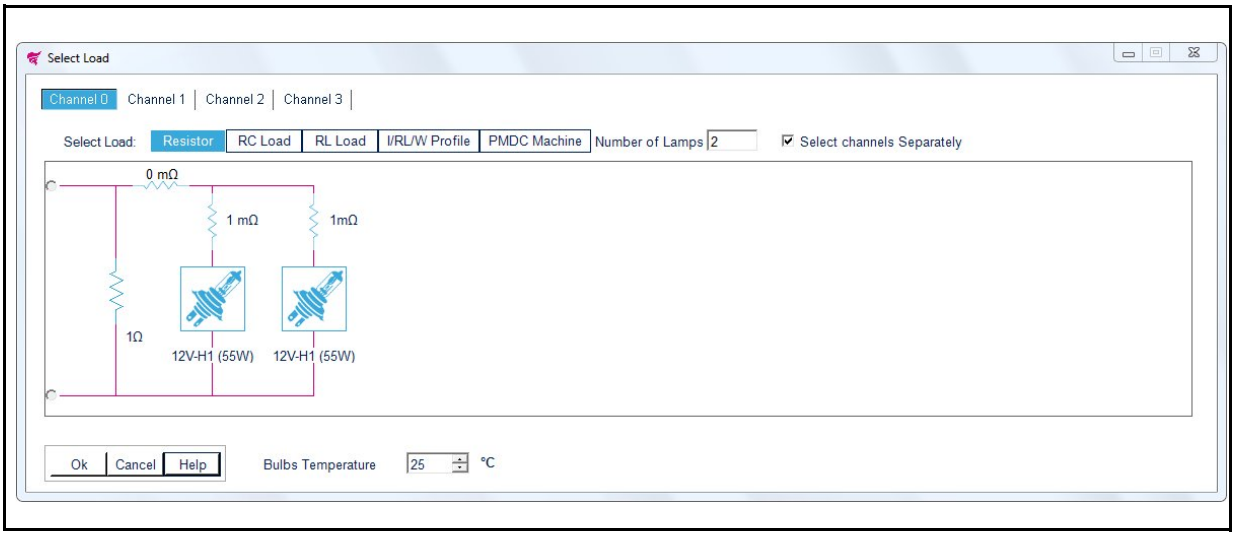
Changes in Input selection disable Current Profile selection
Reset table to enable Current Profile selection with DC source type.

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

2.5 Load selection

Click on the Load icon in the main window, a new frame opens (*Figure 11*) where load parameters for each output channel can be selected.
Number of visible Tabs is equal to the number of output channels for the selected device.

Figure 11. Load selection



Select one of the following loads:

- Resistor (*Figure 12*)
- RC (*Figure 13*)
- RL (*Figure 14*)
- Current, RL or Power Profile (*Figure 15*)
- PMDC Machine (*Figure 18*)

From the counter "Number of Lamps" a maximum of 10 lamps per channel can be selected. If "Select channels Separately" is unchecked, the same load is selected for each channel.

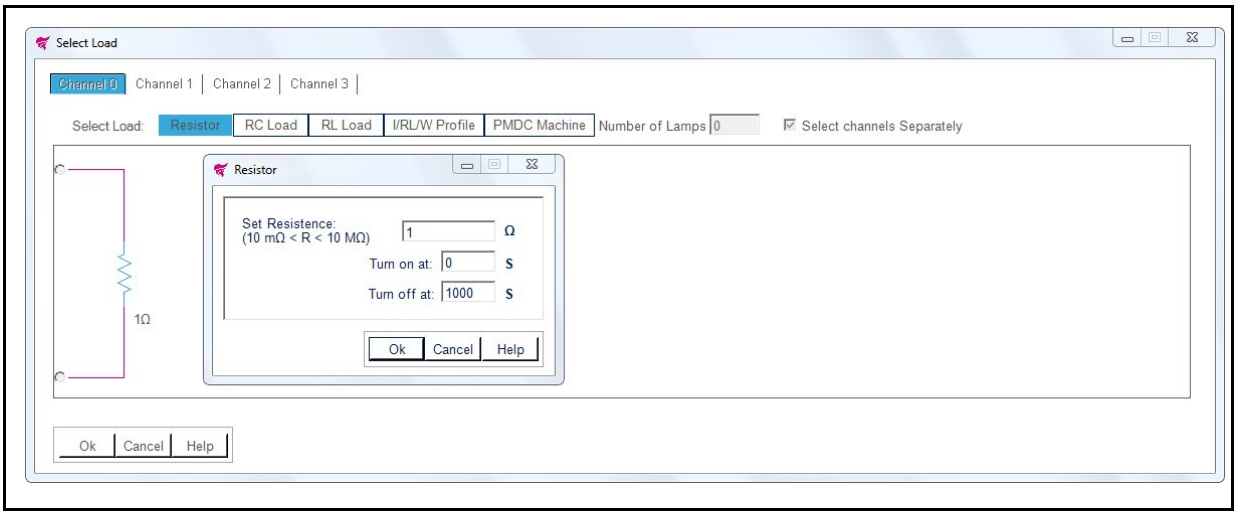
The values of each component in the load can be manipulated. Click on the components icons to change the values.
If no load is selected, an open circuit symbol appears.

- Click **OK** to accept changes
- Click **Cancel** to restore previous layout
- Click **Help** to read the help file on this topic

2.5.1 Resistor as load

Click "Resistor" button to select a Resistive load and then click on the Resistor symbol in the Layout to change its value.

Figure 12. Resistor as load



Change the values manually by inserting them in the numeric boxes.
Values outside the boundaries are automatically restored to the max/min value allowed.
Accepted values are between 10mΩ and 10MΩ for resistance.

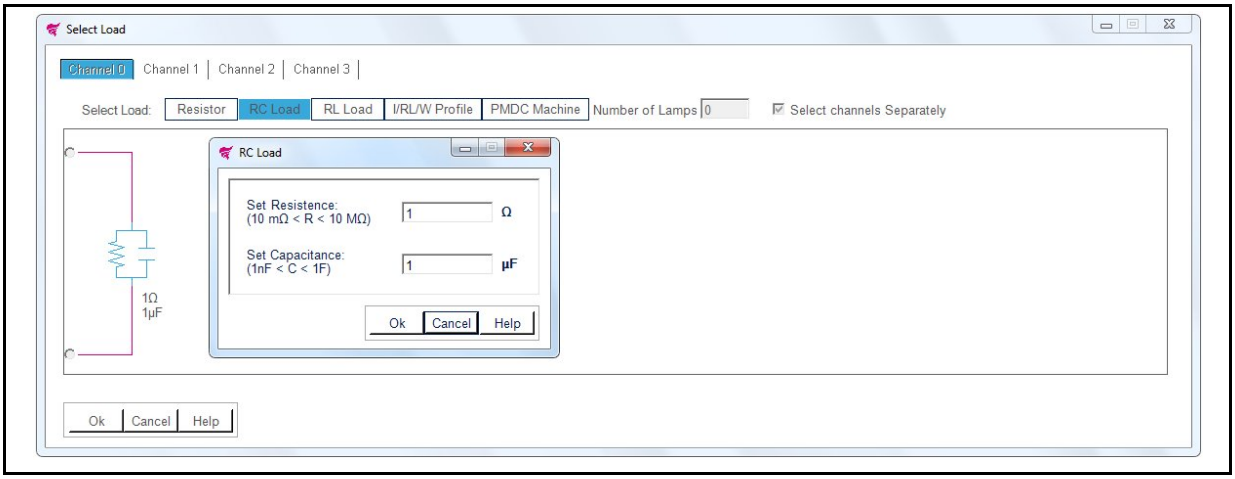
- "Turn On" time: connect Resistor during simulation at a specific time
- "Turn Off" time: disconnect Resistor during simulation at a specific time

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

2.5.2 RC parallel as load

Click "RC Load" button to select an RC parallel load and then click on the Capacitor symbol in the layout to change its value

Figure 13. RC parallel as load



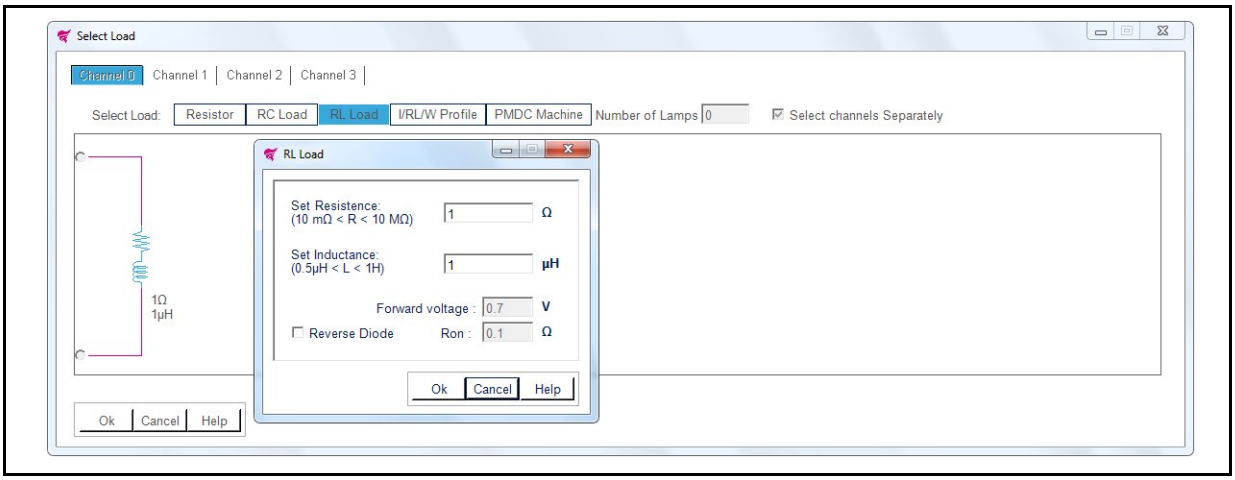
Change the values manually by inserting them in the numeric boxes.
Values outside the boundaries are automatically restored to the max/min allowed value.
Accepted values are between 10mΩ and 10MΩ for resistance and between 1nF and 1F for Capacitance.

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

2.5.3 RL series as load

Click "RL Load" button to select an RL series load and then click on the Inductor symbol in the layout to change its value

Figure 14. RL series as load



Change the values manually by inserting them in the numeric boxes.
Values outside the boundaries are automatically restored to the max/min value allowed.
Accepted values are between 10mΩ and 10MΩ for resistance and between 0.5µH and 1H for Inductance.

Check "Reverse Diode" to select a reverse diode in parallel with RL load.
Accepted values are between 10mV and 1V for "Forward voltage" and between 1mΩ and 1Ω for "Ron".
Reverse Diode is not available for H-Bridge Devices.

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

RL Load disables Lamp selection for selected channel.

2.5.4 Current, RL and device power dissipation profile as load

Channel 1:

- Click "I/RL/W Profile" button to select a Current, RL Load or Power Loss Profile and then click on the corresponding I/RL/W symbol in the layout to change its value.

Channels 2...4:

- Click "I/RL Profile" button to select a Current or RL Load Profile and then click on the corresponding I/RL symbol in the layout to change its value.

Select Current (*Figure 15*), RL Load (*Figure 16*) or Power Loss Profile (1st channel) (*Figure 17*) from the pop-up menu.

Figure 15. Current profile

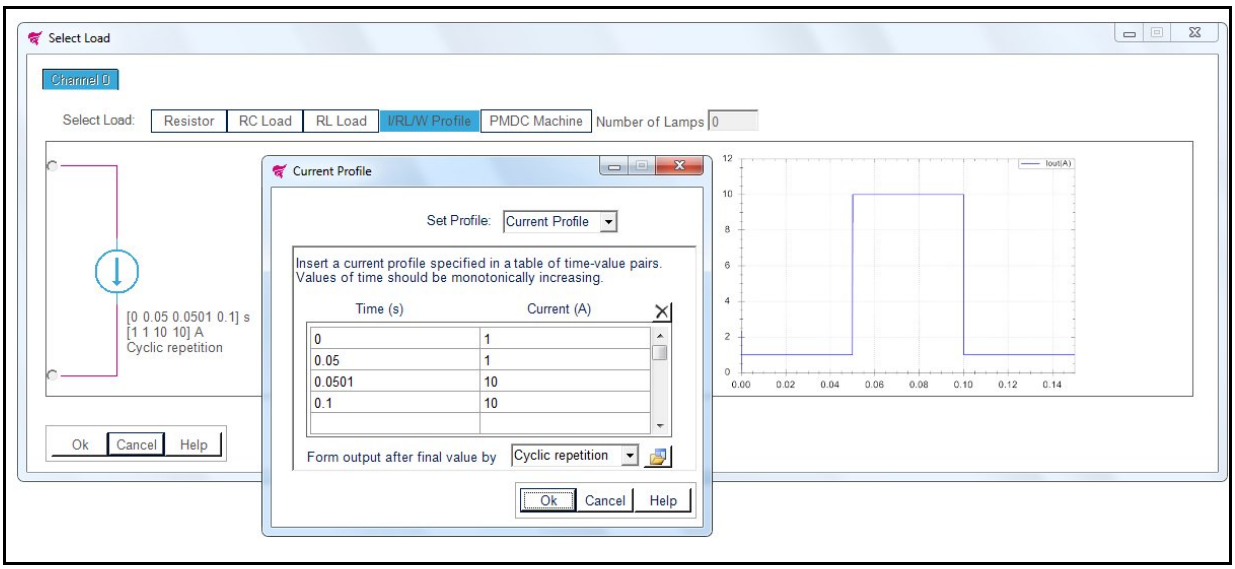


Figure 16. RL load profile

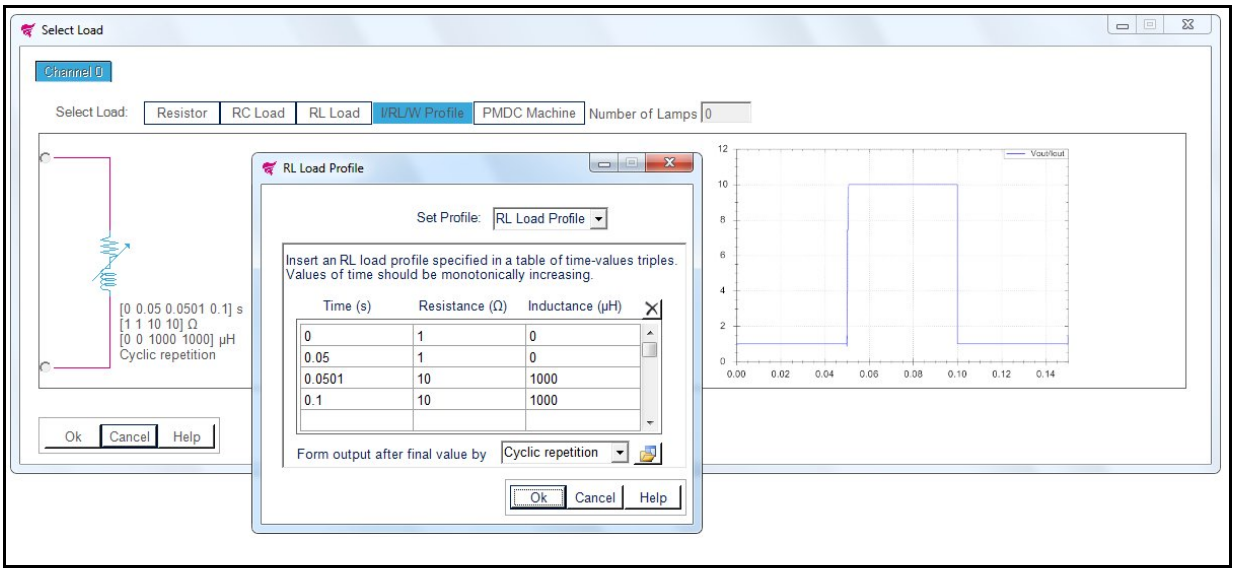
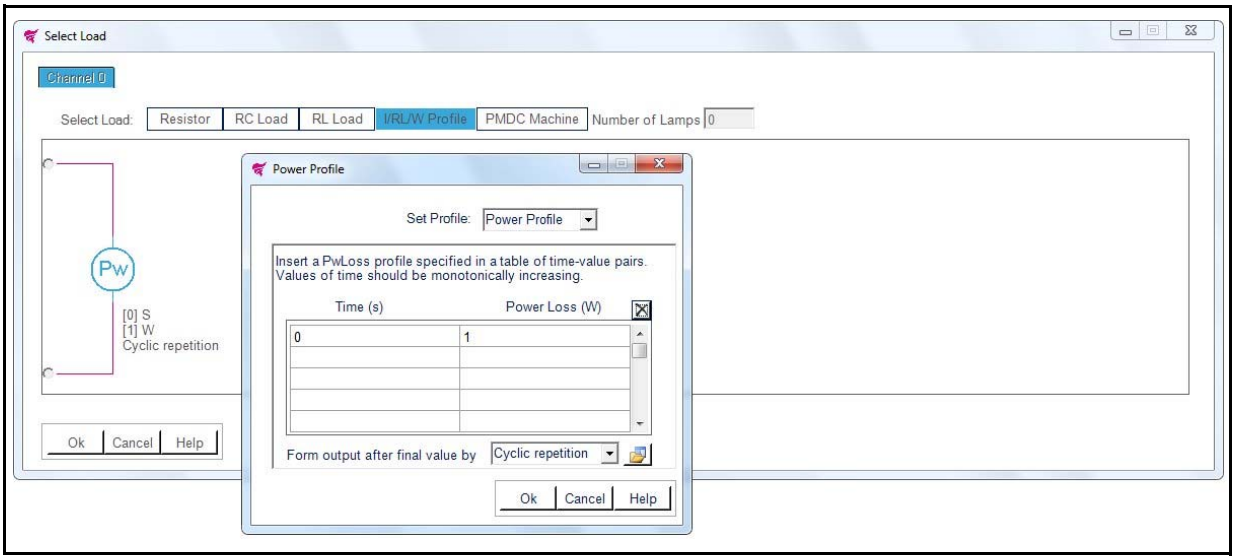


Figure 17. Device power dissipation profile



Insert a custom profile by specifying time-value pairs or triples in the corresponding fields or load values from a .txt/.csv file (time values in the 1st column; Current, Resistance or Power values in the 2nd; Inductance values in the 3rd (Only for RL Load profile), max 150 rows).

For Resistance Profile insert 0 in the Inductance fields.
Define the output after the final value by:

- Cyclic repetition (Current, RL Load or Power values sequence is repeated continuously during the simulation)
- Holding final value (Last Current, RL Load or Power value is maintained throughout the simulation).

Time values must be inserted as a increasing monotonic sequence (i.e., Tn+1>Tn).
Click ✕ to clear table.

Click to load values from file

Establishing a Current Profile, disables PWM selection for the selected channel, Input AB for H-Bridge devices (use negative currents to invert H-Bridge polarity).
Establishing a Power Profile (1st channel) disables PWM, channels and H-Bridge selection.

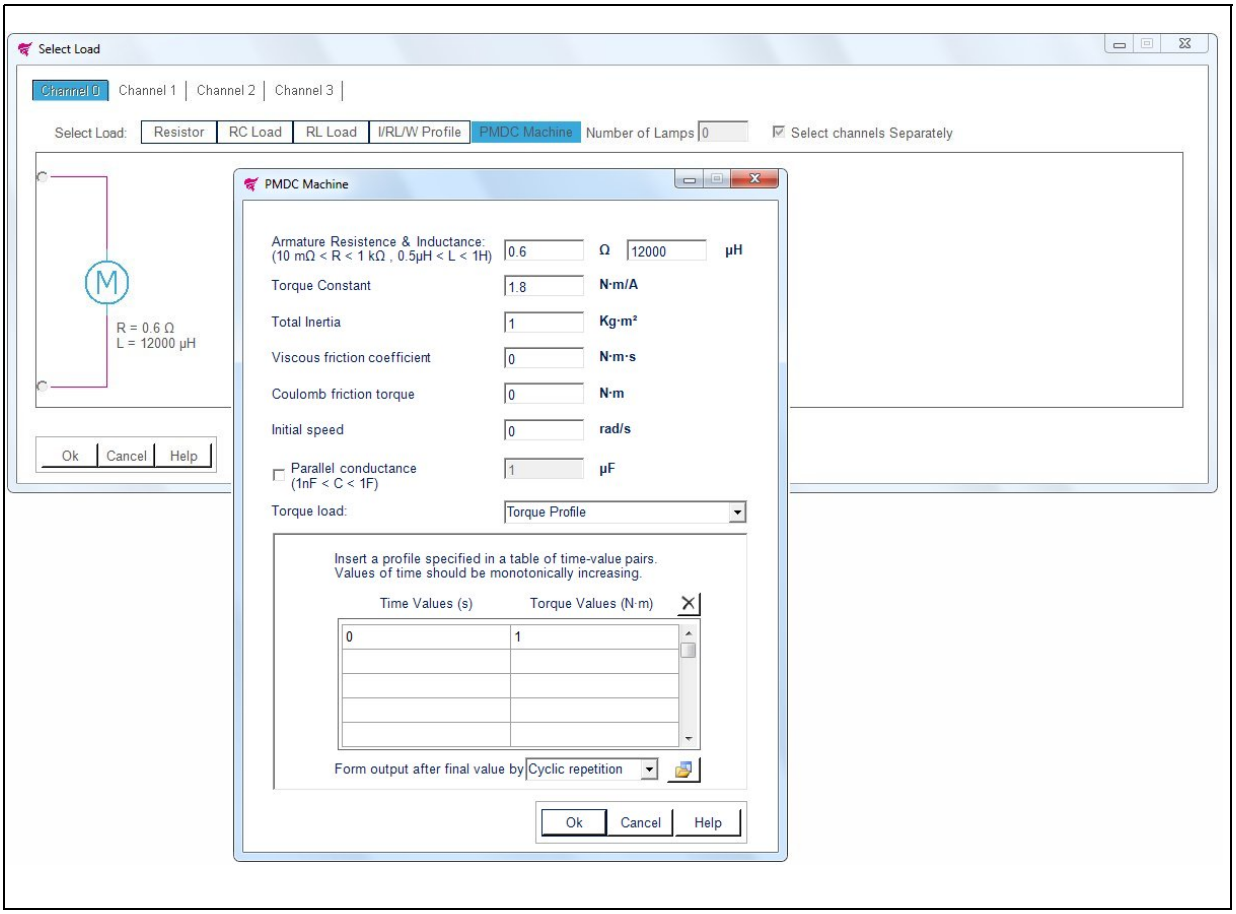
- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

A current (*Figure 15*), RL Load (*Figure 16*) or Power (*Figure 17*) symbol appears in the load layout.
I/RL/W Profile disables Lamp selection for selected channel.

2.5.5 PMDC machine as load

Click "PMDC Machine" button to select a Permanent Magnet DC Machine and then click on the PMDC symbol in the Layout to change its parameters.
Change the values manually by inserting them in the numeric boxes.
Values outside the boundaries are automatically restored to the max/min value allowed.

Figure 18. PMDC machine as load



PMDC Machine parameters:

- Armature Resistance(Ω): The resistance of the winding
- Armature Inductance (H): The inductance of the winding
- Torque constant (N·m/A): The torque per current constant
- Total inertia (kg·m^2): The total inertia momentum of the motor and the load
- Viscous friction coefficient (N·m·s): The total friction coefficient
- Coulomb friction torque (N·m): The total friction torque constant
- Initial speed (rad/s): The initial rotation speed

Check parallel conductance to insert a capacitance in parallel to PMDC machine.

PMDC Specifical signals:

- T_L (N·m): The electromechanical torque load at the input of the DC machine
- T_e (N·m): The electromechanical torque developed by the DC machine
- ω (rad/s): The rotational speed of the DC machine

Mechanical input (Torque Load):

- Hold Motor: Hold motor position (T_L=T_e and ω=0)
- Open Load: No electromechanical torque load at the input (T_L=0)
- Torque Profile: Insert a custom profile by specifying time-values pairs in the corresponding fields or load values from a .txt/.csv file (time values in the 1st column and torque values in the 2nd, max 150 rows).

Define the output after the final value by:

- Cyclic repetition (Torque values sequence is repeated continuously during the simulation)
- Holding final value (Last Torque value is maintained throughout the simulation).

Time values must be inserted as a increasing monotonic sequence (i.e., Tn+1>Tn).

Click ✕ to reset table

Click 📂 to load values from file

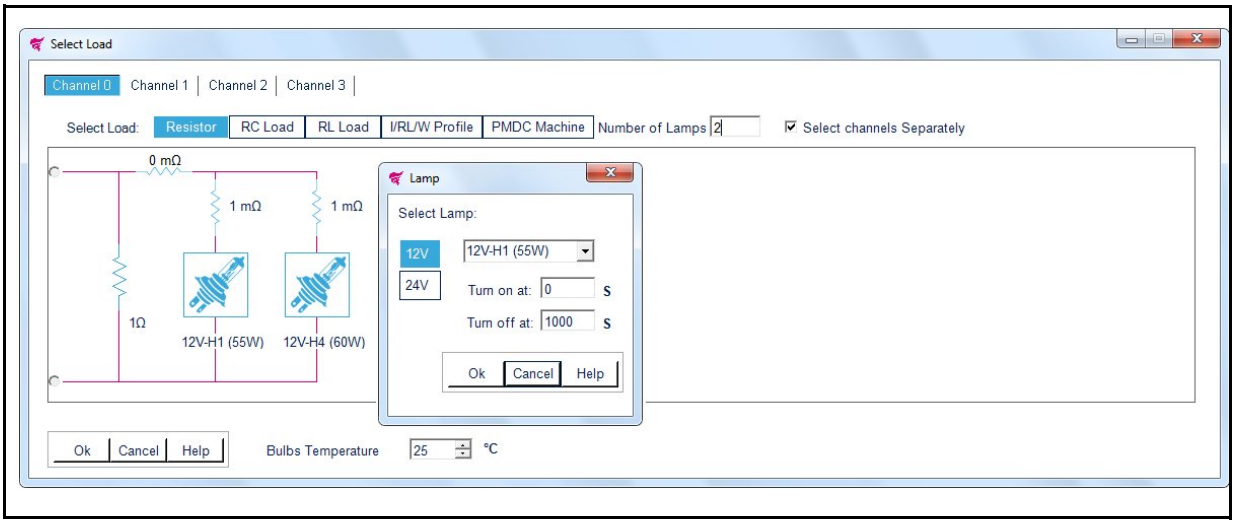
- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

PMDC Machine disables Lamp selection for selected channel.

2.5.6 Lamp as load

Select up to 10 lamps from the "Number of Lamps" counter and then click on a Lamp icon in the layout to change the values.

Figure 19. Lamp as load



Lamps can be placed alone or in parallel to a resistor or a capacitor and they can have different values.
Select a lamp from the drop down menu, according to its voltage and power requirements.

Lamp parameters:

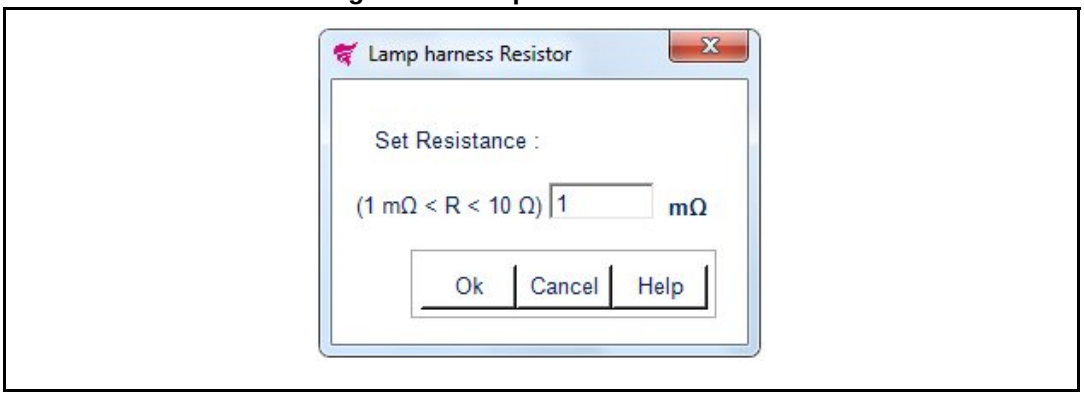
- "12V": select 12V lamps
- "24V": select 24V lamps
- "Turn On" time: connect lamp during simulation at a specific time
- "Turn Off" time: disconnect lamp during simulation at a specific time
- "Bulbs Temperature": Initial filament temperature (°C). Accepted values are between -40°C and 1000°C. This value is common to all lamps inserted

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

Lamp harness resistors

Click on the Resistors symbols in the layout to set a wiring harness lamp resistance for each lamp

Figure 20. Lamp harness resistors



Change the value manually by inserting it in the numeric box.
Values outside the boundaries are automatically restored to the max/min allowed value.
Accepted values are between 1mΩ and 10Ω.

- Click **OK** to accept changes
- Click **Cancel** to restore previous values
- Click **Help** to read the help file on this topic

2.5.7 Thermal electrical simulation setup

- Check the box "Stop simulation when Tjx>" to interrupt the simulation when Tjx is higher than the value specified in the box
- Choose simulation time and then Click "Simulate" button to Start.

Figure 21. Thermal electrical simulation setup

"Step Size" is automatically selected based on the Device/Load configuration.

Changing Step Size affects the simulation speed and accuracy:

For best precision set a lower Step Size. For faster simulation set a higher Step Size.

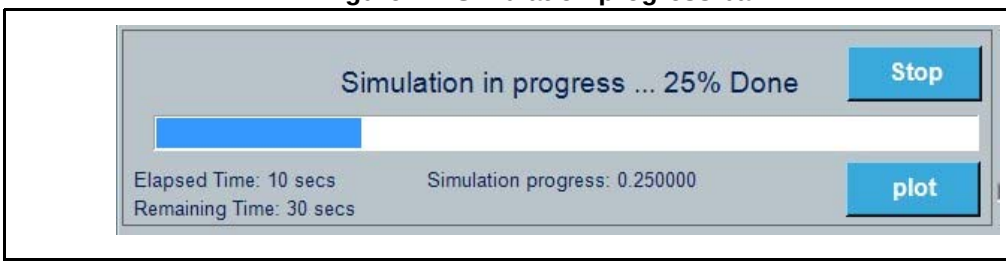
A higher Step Size may cause convergence problems.

"Write data every" is automatically selected based on "Simulation Time" and "Step Size", in order to optimize resolution and memory requirements.

Lower values do not affect simulation accuracy but may cause memory problems.

A progress bar indicates the state of the simulation.

Figure 22. Simulation progress bar



Computation time is principally a function of the kind of load (inductive loads take a longer time), "Simulation Time" and "Step Size" parameters.

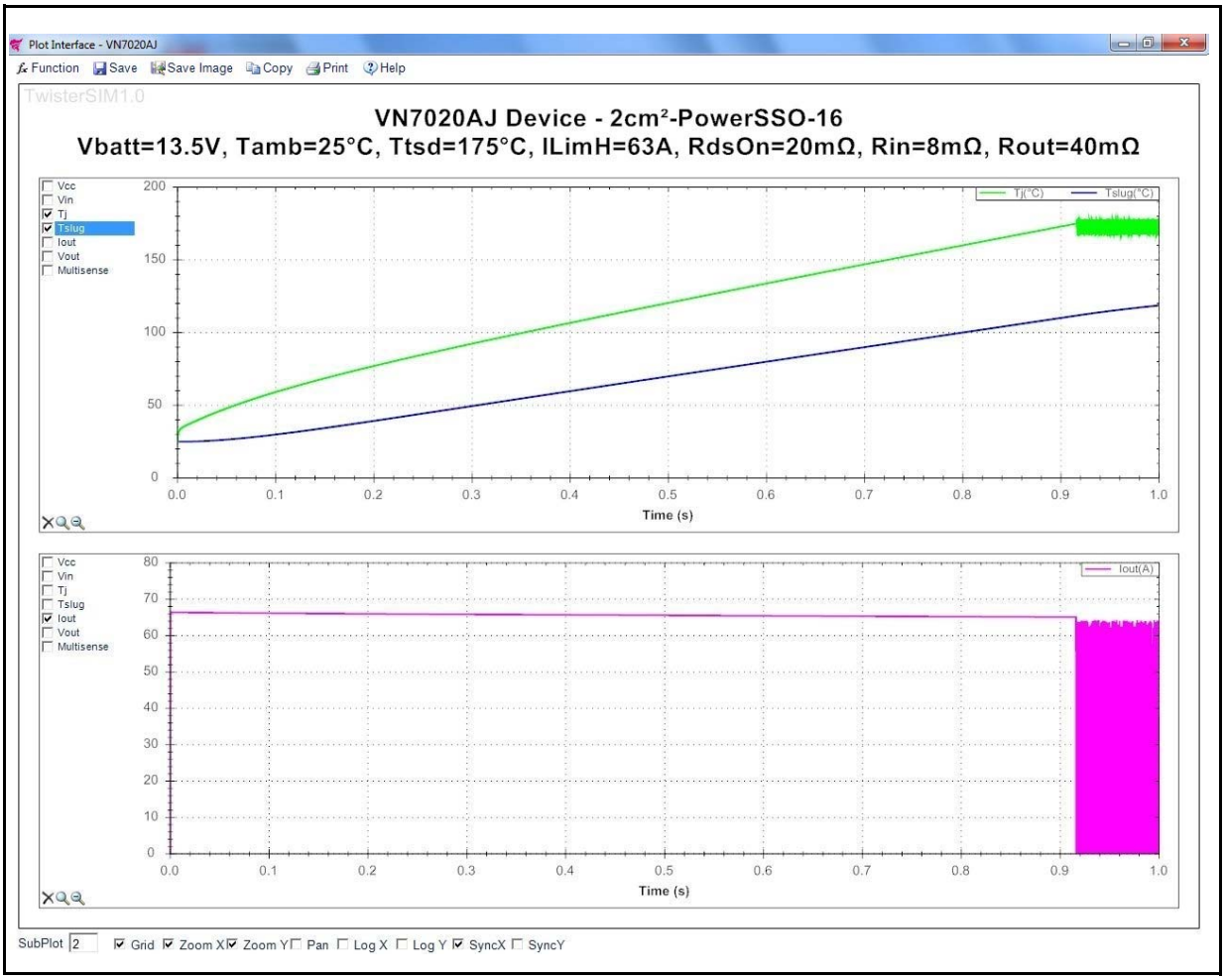
At the end of simulation a plot window shows simulation results.

- Click "Stop" button to stop simulation
- Click "Plot" button to show or reopen Plot window
- Click "Plot" button during simulation to show partial results: A notice in the plot informs about the state of simulation.

2.5.8 Graphical simulation results

When the simulation is over, a new window is opened to show the simulation results.

Figure 23. Graphical simulation results

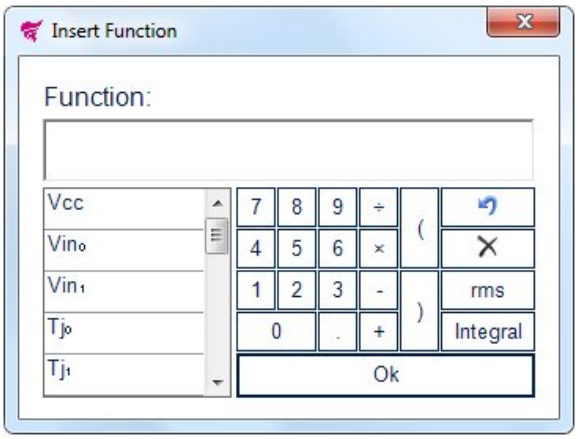


- Left click on the signals list checkbox to add or remove them in the plot (*Figure 23*)
- Right click on the signals to change color, line style or signal name
- Right click on the plot to change titles, un-zoom, un-pan, copy save or print the image
- Change the Subplots number to show simulation results in up to 4 subplots.

- Check "Grid" to show grid lines
- Check "Zoom X" to enable Horizontal zoom
- Check "Zoom Y" to enable Vertical zoom
- Check "Pan" to interactively move the plot view, left clicking on the plot
- Check "Log X" to set logarithmic X axes scale
- Check "Log Y" to set logarithmic Y axes scale
- Check "SyncX" to synchronize Subplots X axes
- Check "SyncY" to synchronize Subplots Y axes

- Click to save the results to a data file for exporting to spreadsheets or a generic text file
- Click to save a picture of the plot
- Click to copy a picture of the plot
- Click to print a picture of the plot
- Click to show this help
- Click to restore the scale ranges to default values
- Click to restore the scale ranges to the values before last zoom
- Click to add signals combination or function to plot:

Figure 24. Create a new function to plot



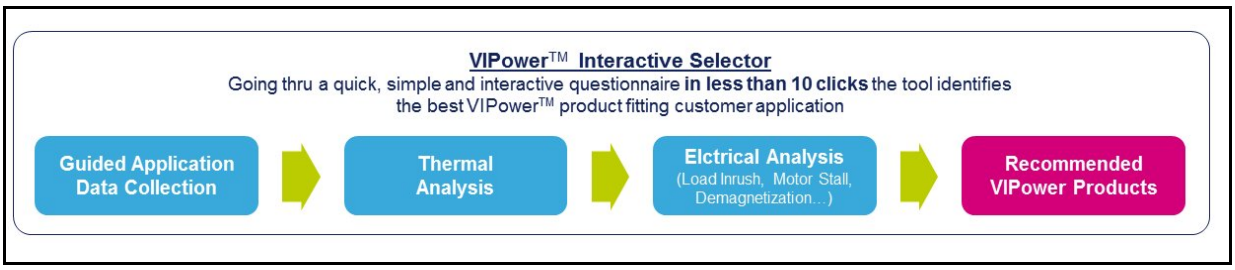
Insert a signal combination or function, clicking or typing in the function field.

- Click **OK** to insert function
- Click **Clear** to clear text
- Click **Cancel** to return to plot

- Click "Plot" button in the main window to show or reopen Plot window
- Click "Plot" button during simulation to show partial results: a notice in the plot informs about the state of simulation

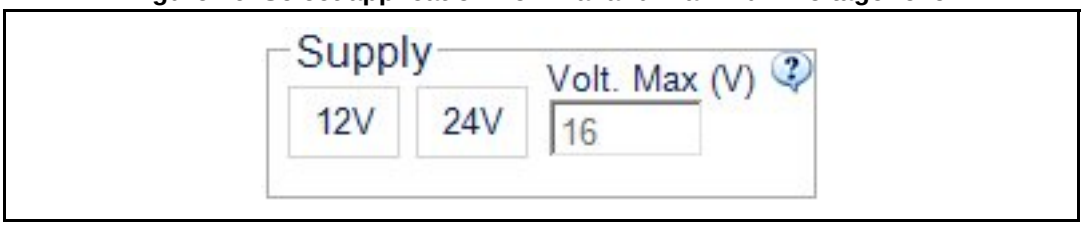
3 VIPower interactive selector overview

Figure 25. VIPower interactive selector


VIPower™ Interactive Selector
Going thru a quick, simple and interactive questionnaire in less than 10 clicks the tool identifies the best VIPower™ product fitting customer application
Guided Application Data Collection
Thermal Analysis
Elctrical Analysis (Load Inrush, Motor Stall, Demagnetization…)
Recommended VIPower Products

3.1 Select application nominal and maximum voltage level

Figure 26. Select application nominal and maximum voltage level



Nominal voltage could be selected between two possible options:

- 12V: for typical Automotive systems or every application based on 12V battery line
- 24V: for Truck or every application based on 24V battery line

Maximum voltage is used by simulation engine to perform worst-case analysis or to set a customized Supply Range.

3.2 Select device topology

Figure 27. Select device topology

In High Side configuration the driver is connected between voltage line and load; the load has the other terminal connected to ground.

In Low Side configuration the driver is connected between load and ground.

- For unidirectional motors driving either High Side or Low Side configuration can be used
- To drive the motor in both directions, H-Bridge configuration is recommended.

3.3 Select number of channels

Figure 28. Select number of channels

High Side Switches are available in Single, Dual and Quad channel configurations.

Low Side Switches are available in Single and Dual channel configurations.

For multi-channel option it is assumed that each channel drives the same selected load at the same time.

3.4 Select load type

Figure 29. Select load type

Figure 30. Resistor as load

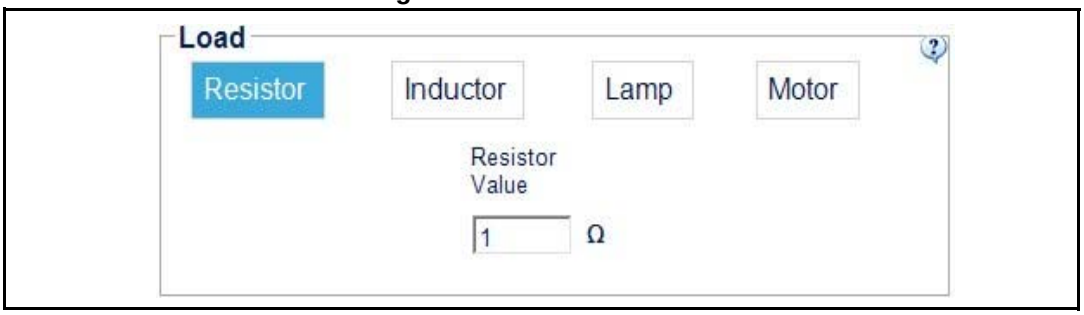


Figure 31. Inductor as load

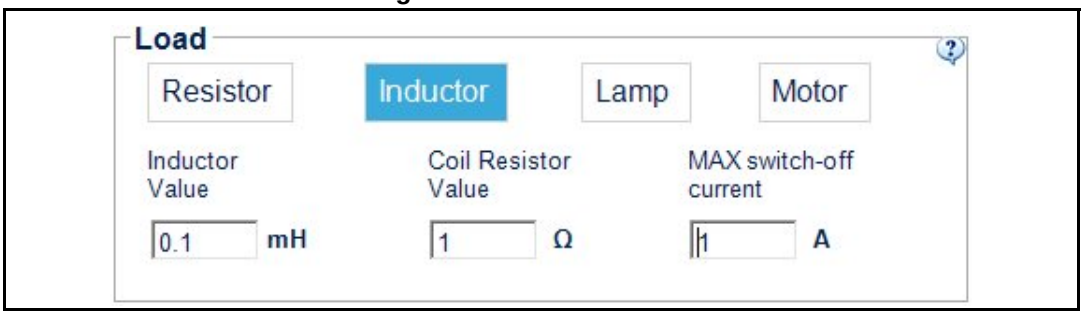


Figure 32. Lamp (by current) as load

Figure 33. Lamp (by Power) as load

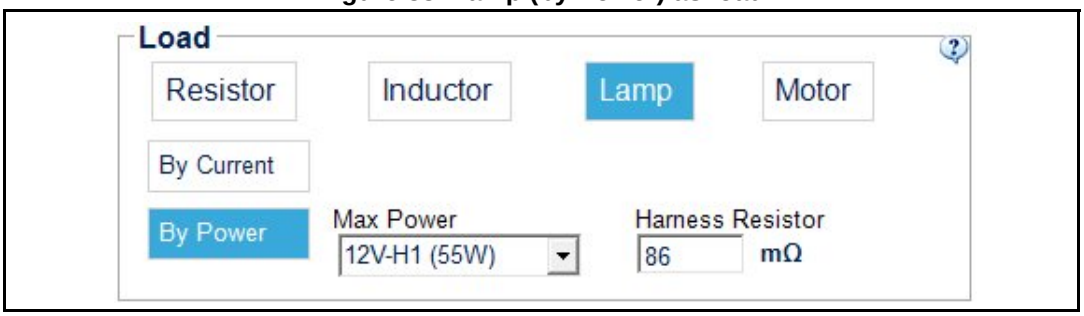
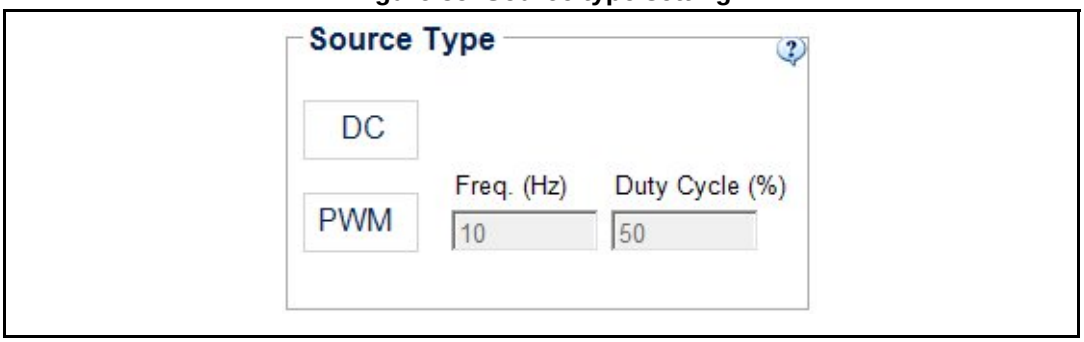


Figure 34. PMDC motor as load

- Resistor: Select this option and input the load resistance (*Figure 30*)
- Inductor: Select this option and input the coil inductance and resistance as well as the coil current when the driver output is switched off (*Figure 31*)
- Lamp: Select this option and input the bulb power or the lamp in rush current and the steady state bulb current (*Figure 32* and *Figure 33*)
- Motor: Select this option and input the motor stall current and the steady state motor current (*Figure 34*)
  The same load is available for each channel.

3.5 Source type setting

Figure 35. Source type setting



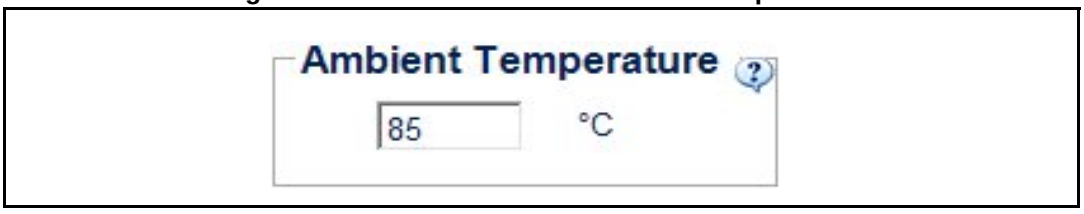
Select if the load is driven in DC or in PWM.

In case of PWM selection input frequency and duty cycle.

- DC: If the application requires activating the load in a continuous mode for indefinite time
- PWM: If the application specification requires to drive the load to a specific frequency and duty cycle.

3.6 Set ambient & initial device temperature

Figure 36. Set ambient & initial device temperature



Environment temperature, under worst-case conditions, is mandatory for selecting the devices with the best thermal fitting.

For standard Automotive applications 85°C is typically used, while it is usually 105°C for Automotive under-hood.

3.7 Select PCB type

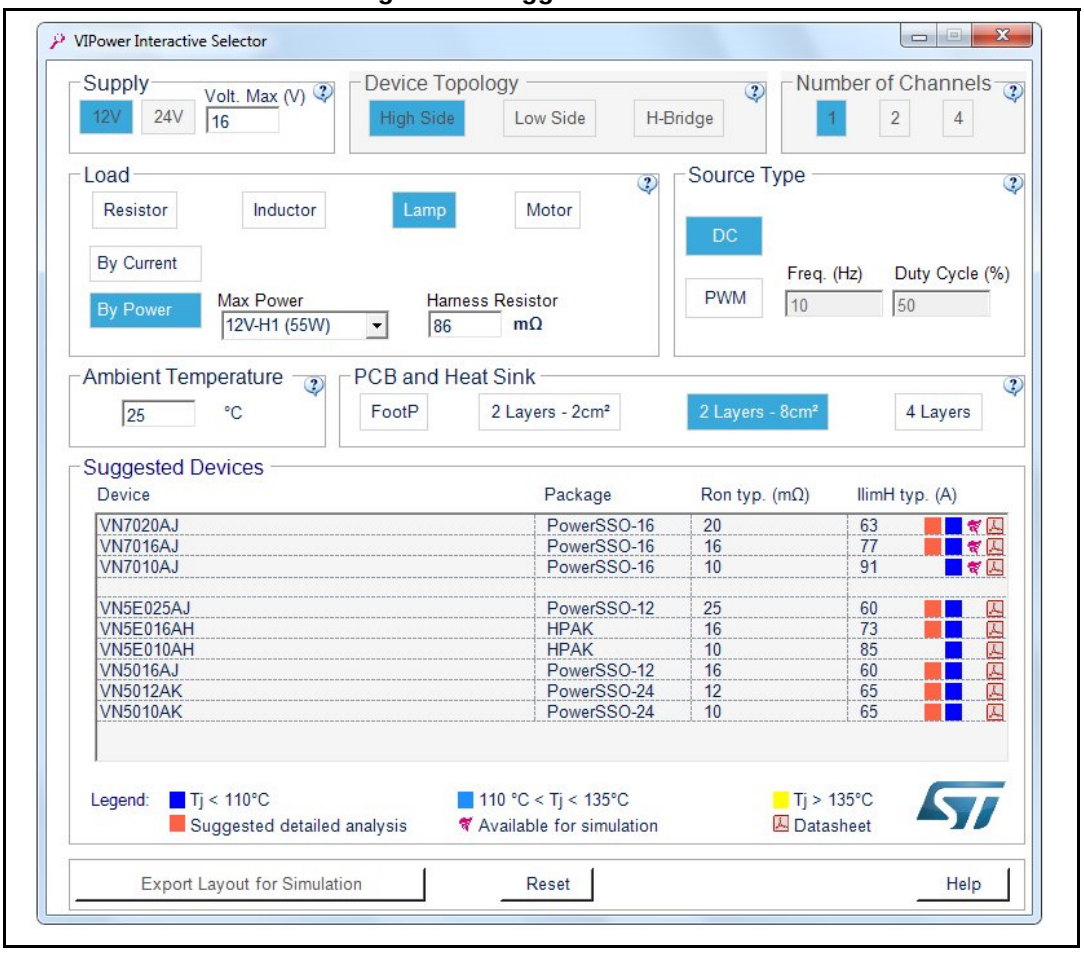
Figure 37. Select PCB type

Select the PCB type in line with the specific application:

FootPrint · 2 Layers - 2cm^2 · 2 Layers - 8cm^2 · 4 Layers

3.8 Suggested devices

Figure 38. Suggested devices



Select one of suggested devices or go back to points 1-7 and change application layout.

- Click **Export Layout for Simulation** to verify selected layout in TwisterSIM for available devices
- Click **Reset** to restart VIPower Interactive Selection
- Click **Help** to read the help file on this topic.

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If a court or agency of competent jurisdiction holds any term of this LLA invalid, illegal, or unenforceable for any reason, the remainder of this LLA shall be valid and enforceable and You and ST shall discuss in good faith a substitute, valid, enforceable provision which most nearly effects the parties intent in entering into this LLA.

The failure by ST to enforce any provisions of this LLA or to exercise any right in respect thereto shall not be construed as constituting a waiver of its rights thereof.

No agency, joint venture, partnership or other business organization shall be created or be construed as being created by reason of this LLA. You will not have the right or authority to,

and shall not, assume or create any obligation of any nature whatsoever on behalf of ST and its Affiliates or bind ST and its Affiliates in any respect whatsoever. You and ST are independent parties. Nothing in this LLA shall be construed as making You an employee, agent or legal representative of ST.

This LLA contains the entire and sole agreement between You and ST on the subject matter of this LLA, and supersedes all representations, undertakings and agreements previously made between You and ST and/or its Affiliates and shall prevail over the terms and conditions set forth in any document from You with respect to the subject matter of this LLA. Any amendment to this LLA shall be agreed in writing and be duly signed by You and ST or signed or agreed solely by You on the format proposed by ST and shall make reference to this LLA.

11. APPLICABLE LAW

This LLA is governed by the laws of Switzerland, without regard to its conflict of law rules. All disputes or questions arising out of or in connection with this LLA shall be finally settled by the competent courts of Geneva, Switzerland. Notwithstanding the aforesaid, nothing in this LLA shall prevent ST from seeking any interim or final injunctive or equitable relief by a court of competent jurisdiction.

Aug2014

Revision history

Table 1. Document revision history

Date	Revision	Changes
13-Mar-2015	1	Initial release.
15-Apr-2015	2	Updated *Figure 3* Deleted some contents in *Chapter 2*
29-Apr-2015	3	Updated cover page.

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